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New Tubes for Television

By the Engineering Department, Aerovox Corporation

With the advent of television the serviceman will meet with an entirely new set of tubes designed to perform special functions in the television receiver. This article deals with the characteristics of these tubes and the reason for their appearance.

The new tubes may be divided into several groups: High-transconductance pentodes, ultra-high-frequency oscillator tubes, special sweep circuit tubes, high voltage rectifiers and cathode-ray tubes. They will be discussed here in this order.

HIGH-TRANSCONDUCTANCE PENTODES

Type 1231 is a pentode with the unusually high transconductance of 5,500 micro-mhos while it has a transconductance of 6,500 micro-mhos when used as a tetrode. Aside from this feature, the tube is of an entirely new type of construction. Supporting leads inside the tube are very short, the number of welds have been reduced and low-loss insulation has been used throughout. A special metal base together with an internal shield provides the necessary shielding. The grid is connected to a base pin which is an advantage at ultra-high frequencies for it makes possible shorter leads. A loktal socket is employed; the metal base connects to the central pin and this one locks into the socket.

Characteristics: Heater, 6.3 volts at 0.45 amp.; plate, 300 volts; screen, 150 volts; bias resistor, 200 ohms; suppressor tied to cathode; plate current, 10.0 ma.; screen current, 2.5 ma.; plate resistance, 0.7 meg.; transconductance, 5,500 micro-mhos; amplification factor, 3,850.

Base connections (RMA numbering): 1, heater; 2, plate; 3, screen; 4, suppressor; 5, internal shield; 6, control-grid; 7, cathode; 8, heater. The central pin should be grounded.

Type 1232, recently released, is a pentode similar to the 1231 in construction but with some improvements. Additional shielding is provided inside the tube, this shield connecting to pin 5. The filament is now rated nominally 7 volts at .48 amp.; it can however be used on 6.3 volts. Characteristics: Plate, 250 volts, max.; screen, 100 volts; control-grid, -2 volts; control-grid for cathode current cut-off, -6 volts; plate current, 6 ma.; screen current, 2 ma.; plate resistance, .8 meg.; transconductance, 4500 micro-mhos; max. plate dissipation, 1.5 watts; max. screen dissipation, 0.2 watts.

The base connections are the same as for the 1231. These two tubes are manufactured by Sylvania only.

Type 1851 is a metal pentode tube with a standard octal base but having a top connecting pin instead of a cap for the grid connection. The pin is the same size as a base pin; this was done to reduce the capacity between the grid terminal and surrounding metal objects. The socket connections are the same as for types 6K7, 6J7, etc.

This tube has an even higher transconductance of 9,000 micro-mhos. It is intended for the r.f. and i.f. stages of television receivers and can also be used as converter, oscillator or the first stage of the video amplifier.

When the gain of the tube is controlled by a.v.c. the screen voltage should be obtained through a dropping resistor of 60,000 ohms. The characteristics of the tube then resemble those of a variable-mu tube with a cut-off at 12 volts. When the screen potential is obtained from a bleeder the cathode current is cut off when the control grid is more than 6 volts negative.

In a.v.c.-controlled stages the varying grid bias causes changes in the tube capacitances which detune the i.f. and r.f. circuits. It has been found possible to reduce this effect by leaving all or a part of the bias resistor un-bypassed. In video amplifiers also, the widest band is obtained when bypass condensers in the cathode circuits are omitted. In such cases the suppressor should not be connected to cathode but to ground.

Characteristics: Heater, 6.3 volts at .45 amp.; plate, 300 volts (max.); screen 150 volts (max.) or 300 volts (max.) through 60,000 ohms; bias resistor, 160 ohms (min.); amplification factor, 6750; plate resistance, 0.75 meg.; transconductance, 9,000 micro-mhos; plate current, 10 ma.; screen current, 2.5 ma.

Type 1852 is similar in characteristics to the 1851 and has the same applications. It differs in construction only; the 1852 is a single ended tube, the grid being connected to a base pin by a specially shielded lead inside the tube.

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It is a metal tube having a standard octal base with the following connections: 1, shell; 2, heater; 3, suppressor; 4, control grid; 5, cathode; 6, screen; 7, heater; 8, plate.

Type 1853 is a single ended metal tube, a pentode with remote cut-off or so-called variable-mu pentode. In other respects it is the same as the 1852.

Characteristics: Heater, 6.3 volts at 0.45 amp.; plate, 300 volts; screen, 200 volts (bleeder) or 300 volts through 30,000 ohms; bias resistor, 190 ohms (min.); plate current, 12.5 ma.; screen current, 3.2 ma.; amplification factor, 3,500; plate resistance, 0.7 meg.; transconductance, 5,000 micro-mhos; grid bias for transconductance of 50 micromhos, -15 volts with screen supplied from bleeder, -22.5 volts with screen supplied through dropping resistor, maximum plate dissipation, 4.4 watts; maximum screen dissipation, 0.65 watt. Base connections are the same as for type 1852.

Type 6AG7 is a beam power amplifier tube for use in the last stage of the video amplifier. This tube combines high transconductance with a high plate current which makes it possible to build a high voltage across a low load impedance. The grid is connected to a base pin and an inter-lead shield prevents hum pickup from the filament leads. This inter-lead shield is connected to base pin number 3 which should be grounded.

This is a metal tube of the same dimensions as a 6F6 and employing a standard octal base.

Characteristics: Heater, 6.3 volts at 0.65 amp.; plate, 300 volts (max.); screen, 300 volts (max.) control grid, -10.5 volts; amplification factor, 770; plate resistance 0.1 meg.; transconductance, 7,700 micro-mhos; plate current, 25 ma.; screen current 6.5 ma.

Base connections: 1, shell and beam-forming plates; 2, heater; 3, inter-lead shield; 4, control grid; 5, cathode; 6, screen; 7, heater; 8, plate.

ULTRA-HIGH-FREQUENCY OSCILLATOR TUBES

As mentioned above, the 1851 or 1852 may be used as oscillators in television receivers and so may the 6J5G and the oscillator portion of the 6K8. The following tube perhaps deserves mention in this connection.

Type HY615 manufactured by Hytron is a small tube with a glass bulb and metal base shell. It is a triode especially designed for high-frequency work. Grid and plate terminals both are brought out to caps on the glass bulb.

Characteristics: Heater, 6.3 volts at 0.15 amp.; plate, 250 volts (max.); plate current, 20 ma. (max.); d.c. grid current, 4 ma. (max.); amplification factor, 20; transconductance, 2,200 micro-mhos; plate resistance, 10,000 ohms; r.f. power output at 300 mc., 2.5 watts.

Base connections: 1, base shell; 2, heater; 4, no connection; 7, heater; 8, cathode.

SPECIAL SWEEP-CIRCUIT TUBES

Type 6AD5G is a high-vacuum triode of the high-mu type with special insulation to withstand high voltage surges. Consequently it may be used with plate supply potentials up to 1,500 volts with a minimum load resistor of 200,000 ohms. In such service it is suitable for supplying the large output voltages required for the deflecting plates of cathode-ray tubes.

The 6AD5G may be used as a blocking oscillator and discharge tube combined by connecting the plate winding of the transformer in series with the charging resistor. This scheme will be further discussed in a future issue of the RESEARCH WORKER. The tube may also be used as an amplifier for saw-tooth wave-forms or with lower plate supply voltages.

Characteristics: Heater, 6.3 volts at 0.3 amp.; plate, 1,500 volts (max.) through 200,000 ohms; bias resistor, 500 ohms (min.).

Low-voltage characteristics: Plate, 250 volts; grid, -2 volts; plate current, 0.9 ma.; plate resistance, 86,000 ohms; transconductance, 1,500 micro-mhos; amplification factor, 100.

The six-pin octal base has the following connections: 1, no connection; 2, heater; 3, grid; 5, plate; 7, heater; 8, cathode.

Type 6R6G is a pentode especially designed for the amplification of saw-tooth wave-forms. It can be used with plate supply potentials up to 1,500 volts if the plate resistor is not less than 100,000 ohms, thus providing a large output voltage. When used as an amplifier with 250 volt power supplies it can be used as a variable-mu pentode and has characteristics resembling type 6D6.

The curved characteristics of the tube are such that they tend to cancel the non-linear signals due to the exponential growth of the condenser charge in the sweep oscillator. The result is a linear saw-tooth waveform.

Characteristics: Heater, 6.3 volts at 0.3 amp.; plate, 1,500 volts (max.) through 100,000 ohms; screen, 75 volts (max.); bias resistor not less than 500 ohms.

The six-pin octal base has the following connections: 1, no connection; 2, heater; 3, screen; 5, plate; 7, heater; 8, cathode. The top cap connects to the control-grid.

The 6AD5G and the 6R6G are manufactured by Arcturus only.

HIGH-VOLTAGE RECTIFIERS

The cathode-ray tubes require very high potentials at very low currents; special rectifier tubes have been designed for this service.

Type 878 is a half-wave, high-vacuum, filament type rectifier enclosed in a glass envelope with four-prong base and top cap. Its ratings are: filament, 2.5 volts at 5.0 amps.; maximum a.c. plate voltage, 7,000 r.m.s.; maximum peak inverse voltage, 20,000 volts; maximum continuous output current, 5 ma.

Base pins No. 1 and 2 are connected together inside the base as are pins 3 and 4; this was done to provide additional contact for the heavy filament current. The plate is connected to the top cap.

Type 879 is a half-wave, high-vacuum, filament type rectifier of lower rating than the 878. It is enclosed in a glass bulb of the same size as type 6D6 and is supplied with a four-prong base. Ratings: filament, 2.5 volts at 1.75 amps.; max. a.c. plate voltage, 2,650 volts r.m.s.; maximum peak inverse voltage, 7,500 volts; max. peak plate current, 100 ma.; max. continuous output current, 7.5 ma.

The filament connects to base 1 and 4 of the base; the other base pins have no connection. The plate is brought out to the top cap.

Type 2V3G is a half-wave, high-vacuum rectifier with a tungsten filament. Its glass envelope and top cap are the same size as that of the G-tubes 6K7G, 6L7G, etc. It is fitted with a six-pin octal socket; the tube must be mounted in a vertical position and the contacts should be capable of carrying 5 amperes.

Ratings: Filament, 2.5 volts at 5 amperes; peak inverse voltage, 16,500 volts (this corresponds to approx. 5,800 volts r.m.s maximum a.c. plate voltage); peak plate current, 100 ma.; maximum average plate current, 2 ma.

The filament connections are pin 2 and 7; the plate connects to the top cap.

The following two special rectifiers are manufactured by Arcturus only.

Type 2Y2 is a half-wave high-vacuum rectifier with an indirect slow heater. The heating has been made slow so as to delay the appearance of the light spot until the sweep circuits are oscillating so that there will be no burning of the screen.

Ratings: Heater, 2.5 volts at 1.75 amps.; maximum a.c. plate voltage, 4,400 volts r.m.s.; maximum peak inverse voltage, 12,000 volts; maximum continuous output current, 5.0 ma. If the tube is used with condenser input circuits, the input condenser should not exceed 0.5 mfd.

The tube has a four-prong base; 1, heater; 2 and 3, no connection; 4,

heater and cathode. The plate is connected to the top cap.

Type 5X3 is a full-wave, high-vacuum filament type rectifier similar to an 80 in appearance and connections. It may be used at low voltage, up to 400 volts r.m.s. per plate with a maximum output current of 110 ma. It can also be used as a high voltage rectifier if the output current is kept below 30 ma. The maximum a.c. voltage per plate is then 1,275 volts r.m.s.; the maximum peak inverse voltage, 3,600 volts.

The tube may be used either with choke or condenser input filters.

CATHODE-RAY TUBES

Below is given the data on cathode-ray tubes for television manufactured by DuMont, National Union, RCA and Sylvania. The different companies have different trade names for these tubes: Teletron, Videotron and Kinescope. The tubes in the 1800 series are available from National Union, RCA and Sylvania; others are made by but one manufacturer which will be indicated.

Compared to tubes for oscillographs, television tubes have some requirements of their own. The trace must be fine and brilliant and should not go out of focus at the edges of the pattern; the electron beam must lend itself to modulation.

In order to increase the brilliance and fineness of the trace, an extra element has been placed in the tube. In some tubes this takes the form of a screen grid or accelerating grid located between the control grid and the focusing electrode. It is given a potential of about 200 to 250 volts with respect to cathode and its purpose is to accelerate the electrons.

Greater speed of the electrons means lower sensitivity of the deflecting plates. In the DuMont tubes an extra element, the intensifier, is used which speeds up the electron after it has already been deflected. In this way the sensitivity is not lost. The element is located close to the screen and is maintained at the potential of the anode or up to several thousand volts higher.

Originally each manufacturer assigned his own type numbers but now RMA has standardized them. Thus some tubes are sometimes indicated by a double number both the RMA and the old designation. In addition, the old designation carried a hyphen and P1, P2, P3 or P4. These refer to the type of phosphor employed on the screen and the color of the picture. P1 stands for green: P2, blue: P3, yellow and P4, white. Thus 906-P1 is the old familiar tube with the green trace; 906-P4 denotes the same tube with a white trace. Adding the RMA numbers these same tubes are called 3AP1/906-P1, and 3AP4/906-P4. The idea is of course that we shall forget these old designations and just call them 3AP1, 3AP4. Note that in the RMA designations the first numeral or numerals indicate the diameter of the screen in inches while the color of the screen is shown by the last two characters.

Cathode-ray tubes must be treated with respect; they are sensitive to knocks, scratches, strains and differences in temperature. No force should be applied to put them into their sockets; especially not around the rim. Some of the larger tubes come equipped with a shield to protect the tube as well as the operator. This shield should not be removed; a sheet of plate-glass or non-shatterable glass should be placed over the screen after installation so as to protect the tube from scratches or jars and to protect the operator in case of breakage.

Type 1801-P1 and 1801-P4 are five-inch tubes of the magnetic deflection type. They have deflection plates. These tubes can be operated with 3,000 volts (max.) on the anode and 450 volts on the focusing electrode or 2,500 volts on the anode and 375 volts on the focusing electrode. The filament requires 2.5 volts at 2.1 amps.

The tubes are fitted with a five-pin base: 1, heater; 2, focusing electrode; 3, control grid; 4, cathode; 5, heater. A cap on the side of the tube connects to the anode.

Types 1802-P1, 1802-P4 (5BP1/1802-P1, 5BP4/1802-P4) are five-inch tubes of the electrostatic deflection type. These tubes have no accelerating grids. The four deflecting plates are brought out to four different base pins. Ratings: Heater, 6.3 volts at 0.6 amp.; anode, 2,000 volts (max.); focusing anode, 1,000 volts (max.); peak voltage between any deflecting plate and anode, 500 volts. The following voltage combinations for anode and focusing electrode are practical: 1,200 and 250 volts; 1,500 and 310 volts; 2,000 and 425 volts.

The tubes are equipped with an eleven-pin base; the connections are: 1, heater; 2, no connection; 3, D1; 4, focusing electrode; 5, connected to 4; 6, D4; 7, anode; 8, D2; 9, D3; 10, control grid; 11, heater and cathode. D1 and D2 are the outer deflecting plates

Type 1803-P4 (12AP4/1803-P4) is a twelve-inch tube of the electro-magnetic deflection type. It has an accelerating grid placed between control-grid and focusing electrode. Ratings: Heater, 2.5 volts at 2.1 amp.; anode, 7,000 volts max.; focusing electrode, 1,900 volts max.; accelerating grid, 250 volts max. Voltage combinations: 250, 1,240 and 6,000 volts; 250, 1,460 and 7,000 volts.

The tube is equipped with a six-pin socket; the connections are: 1, heater; 2, focusing electrode; 3, accelerating grid; 4, control grid; 5, cathode; 6, heater. The anode connects to a cap on the side of the tube.

Type 1804-P4 (9AP4/1804-P4) is a nine inch tube of the magnetic deflection type. Its maximum ratings and base connections are the same as for the 1803.

Types 5AP1 and 5AP4 (5AP1/1805-P1, 5AP4/1805-P4) are five-inch tubes of the electrostatic deflection type. These are the so-called "short" tubes. The overall length is 3-5/8 inches less than that of the 1802. In all other respects the characteristics and connections are the same as those of the 1802.

The following three types are made by DuMont; they are all of the electrostatic deflection type.

Type 54-11-T is a five-inch tube, similar to the 1802 except for the addition of the intensifier. When the intensifier is connected to the anode the tube is interchangeable with the 1802. The following are workable voltage combinations for focusing electrode, anode and intensifier: 250, 1,000 and 2,000 volts; 375, 1,500 and 3,000 volts; 500, 2,000 and 4,000 volts.

Type 94-11-T is a nine-inch tube also containing an intensifier. This element is connected to a cap at the side of the tube; otherwise it has the same 11-pin base with the same scheme of connections as the 1802 and the 54-11-T. Ratings: Filament, 6.3 volts at 0.6 amps.; intensifier, 10,000 volts max.; anode, 5,000 volts max.; focusing electrode, 2,000 volts max. The following voltage combinations are practical: 3,000, 1,500 and 375 volts; 600, 3,000 and 750 volts; 9,000, 4,500 and 1,125 volts.

Type 144-9-T is a fourteen-inch tube and does not have an intensifier. Ratings: Filament 2.5 volts at 2.1 amp.; anode, 6,000 volts max.; focusing electrode, 1,800 volts. Voltage combinations: 3,000 and 6,000; 4,500 and 1,350; 6,000 and 1,800. This tube is equipped with a special 12-pin base having the following connections: 1, no connection; 2, control-grid; 3, heater and cathode; 4, heater; 5, no connection; 6, focusing electrode; 7, no connection; 8, D1; 9, D2; 10, anode; 11, D3; 12, D4.

National Union Type 2,005 is a five-inch tube of the electrostatic deflection type. It differs from the 1802 in that two of the deflecting plates are connected to the anode inside the tube and that it has a screen grid. Ratings: Heater, 2.5 volts at 2.1 amp.; anode, 2,000 volts max.; focusing electrode, 1,000 volts maximum; accelerating grid, 200 volts maximum. The tube is equipped with an octal base having the following connections: 1, anode and D2 and D4; 2, heater; 3, focusing electrode; 4, D1; 5, control-grid; 6, D3; 7, heater and cathode; 8, accelerating grid.

Information for this article was furnished by the manufacturers.

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38 U6D-U6	GCC-125C	4-8-16	150	④ 1⅜x3	2.35
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